A STUDY OF THREE COMPETITIVE SWIMMING FRONT RACING STARTS

An abstract of a Field Report by
J. Tom Cady
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Drake University
Advisor: Charles Heilman

The problem. The purpose of this study was to compare three competitive swimming front starts: the conventional arm swing start, the grab start, and the grab (butterfly) start.

Procedure. Thirteen experienced competitive swimmers (six female and seven male) did each of the three starts a total of six times. The middle four times for each start were used as data to determine the means for each of the three starts for each subject.

All starts were filmed and timed to measure these three factors:

1. The time elapsed from the starting signal to the time the subject's feet left the starting block.
2. The distance the subject traveled in the air.
3. The time from the starting signal to a distance of fifteen feet from the starting block.

Findings. An analysis of variance proved to be statistically significant in one of the measured factors: The time elapsed from the starting signal to the time the subjects' feet left the blocks. For this factor, there was an advantage for the two grab starts over the conventional start. The study did not show any significant differences in the other two factors; however, some differences were noted with individual subjects.

A STUDY OF THREE COMPETITIVE SWIMMING FRONT RACING STARTS

A Field Report

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by

J. Tom Cady

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J. Tom Cady

Approved by Committee:

Charles Heilman
Chairman

Ray Pugh

Earle L. Canfield
Dean of the School of Graduate Studies

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table Page

Chapter 1

INTRODUCTION

STATEMENT OF PROBLEM

Since the introduction of the grab start in 1967, a great deal of controversy regarding its merits has developed. Questions about it are debated at coaches' clinics and in swimming technique literature.

In his study, Jorgenson felt no real advantage existed for the grab start,[1] while Hanauer suggested the grab start was faster.[2] This investigator observed that all the finalists in the 50 yard freestyle at the 1971 National Collegiate Athletic Association Swimming Championships at Ames, Iowa, and in the 1972 Championships at West Point used the grab start.[3] Yet, some of the world's best swimmers are observed using the conventional arm swing start.

Coaches debate that while one start may be faster

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[1]Layne W. Jorgensen, "A Cinematographic and Descriptive Comparison of Three Selected Freestyle Racing Starts in Competitive Swimming" (unpublished Doctoral dissertation, Louisiana State University, 1971), p. 6.

[2]Eric S. Hanauer, "The Grab Start," Swimming World, 13 (June, 1967), 42.

[3]Richard A. Michaels, "A Time Distance Comparison of the Conventional and the Grab Start," Swimming Technique, 6 (October, 1969), 69.

off the block than another, its advantages may be negated by a loss of distance of air travel.[1] Thus, it becomes important for both swimmers and coaches to understand the differences between the starts.

With the advent of the electronic timer and the increased number of swimming publications dealing with scientific studies of technique, swimming is no longer just a sport but a sport of science. Many swimming races are decided to the nearest one-hundredth of a second. Some races appear to have finished in a tie but are settled by electronic equipment that cannot allow a tie. In 1972, the Olympic 200 meter breast stroke championship for men was decided electronically by two-thousandths of a second.

Based on these developments, most swimming coaches are interested in considering any technique which might gain as little as one-tenth of a second for a competitor. Eating and training habits are logged and studied. Swimmers have been tested, observed, and photographed as they go through their starts, turns, and strokes. Actions are analyzed in an effort to discover the physiological and kinematical optimum gain to be made by each body movement.

This study made a comparison in both time and distance of three styles of racing starts used in competitive

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[1]James Counsilman, The Science of Swimming (Englewood Cliffs: Prentice-Hall Inc., 1968), pp. 133-142.

swimming. Two of these starts, the conventional arm swing and the grab start are the most frequently used starts in swimming competition. The third start is a modification of the grab start, the butterfly grab start.

Data were presented by this study to answer the following questions:

1. How do the three starting techniques compare in the fastest mean time off the starting blocks?
2. How do the three starting techniques compare in distance of air travel from the starting blocks?
3. How do the three starting techniques compare in time used in traveling the first fifteen feet of the course?

DESCRIPTION OF STARTING TECHNIQUE AND EQUIPMENT

Conventional Start

The swimmer assumes a set position with hands forward, approximately six inches in front of the starting block. The feet are placed in a comfortable position, usually shoulder width apart, approximately twelve inches, with the toes curled over the edge of the block. The knees should be slightly flexed, and the shoulders level with or slightly lower than the hips. At the starting signal, the arms swing forward, outward, backward, inward, and again forward, describing a small circular action. The arms should be stopped at about a 135 degree angle from the body.

The head should be dropped at the starting signal and then lifted vigorously as the arms complete the forward swing of the arms.[1]

Grab Start (Method I)

The swimmer assumes the set position with the fingers gripping the front of the starting block and placed outside the feet. The fingers grasp at the first or second joint, usually two to three inches below the feet. At the starting signal, the swimmer pulls down, forcing the body to lean, then releases the grip and swings the arms forward to a line with the body. The head should drop at the starting signal and be lifted at the forward swing of the arms.

Grab Start (Method II) - "Butterfly Start"

The set position and the action at the starting signal are the same as for the grab start (Method I). The difference is that at the release of the hands, the arms are brought upward and forward, sideways, in an action similar to the action of the recovery of the butterfly stroke. The head should be first dropped at the starting signal and then lifted as the arms are brought forward.

Electronic Timing Device

The subjects were timed by the Dekan Automatic Performance Analyzer. Powered by electric current, it times

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[1]Counsilman, p. 67.

to the nearest one/one-hundredth of a second. The starter's pistol was attached to an impact switch connected by an extension cord to the machine. At the discharge of the pistol, the timing device and a signal light attached to the front of the starting block were activated. The signal light was located so as to show on the film and provide the researcher a reference point in the frames to indicate when the start occurred.

The timer was stopped and the light turned off by a break contact switch connected by a string to a waistband of the subject. This switch was designed to disconnect at exactly fifteen feet from the starting block.

Photographic Equipment and Placement

The camera was an electric powered Kodak Super Eight mounted stationary on a railing at a distance that allowed the complete start and entry into the water to be photographed without moving the camera. The swimmers were photographed at a camera speed of sixty-four frames per second.

ORGANIZATION OF THE REMAINING CHAPTERS

A review of the literature pertaining to the opinions of experts and to the available research data for the front racing start is presented in Chapter 2. The procedures used to train and test the subjects, as well as the methods of collecting and analyzing the data, are presented

in Chapter 3. The results of this study are discussed and analyzed in Chapter 4. Conclusions and recommendations are presented in Chapter 5.

Chapter 2

REVIEW OF RELATED LITERATURE

In the years from 1967 to 1975, a great deal of discussion at coaches' meetings and clinics took place concerning the use of the grab start. At first, the talk was based on personal experiences and observations of the coaches, with little data and research to verify their beliefs. Most did agree, however, that nearly all swimmers who used the new grab start appeared to be gaining an advantage over the ones still using the conventional start. Gradually, research reports comparing the two starts began to appear. This chapter discusses chronologically some of these reports.

Hanauer described his experiences with one of his swimmers in the June 1967 issue of Swimming World, stating the grab start seemed to give his swimmer not only a mental edge but additional speed off the block.[1] He listed the following observations:

1. The bunched effect with the swimmer in a slightly crouched position, like the bunch start in track, allows the swimmer to leave the block with greater velocity.

2. Because of the added base of support, the grab start affords greater stability and the swimmer is less likely to false start.

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[1]Eric S. Hanauer, "The Grab Start," Swimming World, 13 (June, 1967), 42.

3. The grab start moves the upper body parallel to the surface of the water sooner than the conventional starts.

4. The grab starter leaves the block sooner, flies straighter and lower, and hits the water sooner than the conventional starter.

5. The grab start is more advantageous for a short person than for a tall one.[1]

Hanauer's observations raised many questions about the start, and some of his early observations proved to be true in the research studies that followed the publication of his article.

Winters made a comparison of the two starts in 1968, using five Southeast Missouri State University varsity swimmers. In his study, the swimmers' starts were compared, using photographic evidence. He concluded the grab start, or "grip" start as he called it, was significantly faster than the conventional on the time it takes to leave the blocks, the time it takes to enter the water, and the velocity of the swimmer upon entering the water. Winters reported a .325 second advantage for the grab start in 30 feet of freestyle race.[2]

In the years 1968 to 1971, little research was

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[1]Hanauer, p. 42.

[2]Clifford N. Winters, "A Comparison of the Grip Start and the Conventional Start in Competitive Swimming" (unpublished Master's thesis, Southeast Missouri State College, 1968), p. 68.

reported comparing these two starts, even though the grab start gained popularity. By 1971, the grab start was commonly used in freestyle and butterfly events, and the debate among coaches continued.

In 1971, Jorgensen conducted a doctoral study on 75 "age group" swimmers. His findings were inconclusive, and he finished his summary by stating,

> From a mechanical stand point, the grab start appeared to be the simplest. However, when selecting a freestyle racing start, the swimmer should experiment with all three starts and select one which is most comfortable and economical to him.[1]

His study did little to answer the questions about the apparent advantages of the grab start because he did not have the same subject do each of the three starts.

By 1972, swimming coaches were conducting their own experiments. Roffer and Nielson did a cinematographic study using nine Pennsylvania State University varsity swimmers. The authors' results, on the basis of ninety trials, indicated the grab start was faster from the starting signal to the feet leaving the block for all subjects. It was faster to 12 feet by .1 second when compared to the conventional start. They concluded the main advantage of the grab start was in the reduced time spent on the block.

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[1]Layne W. Jorgensen, "A Cinematographic and Descriptive Comparison of Three Selected Freestyle Racing Starts in Competitive Swimming" (unpublished Doctoral dissertation, Louisiana State University, 1971), p. 87.

Because of the short duration of time, it was impossible to determine whether this time gain was maintained after the swimmer began his stroke.[1]

In his second article on the grab start, Hanauer credits the time improvement of his all-American Steve Estabrook to the use of the grab start.[2] He summarized his study of just one swimmer by stating that Estabrook, using the grab start, hit the water 15/64 second faster than the conventional start, but the conventional start went 8-1/2 inches farther in the air. An advantage of 15/64 seconds was calculated for the grab start to a distance of 18 feet 9 inches. He concluded that further studies should be made to compare the advantages of each of the starts. Table 1 shows the results of the study.

In a 1973 publication, Michaels reported on testing six Oberlin College varsity swimmers on five alternating grab and conventional starts. The subjects were timed with an electronic timing device, activated by the starting gun and stopped with a hand held button over a distance of 25 feet from the starting block. None of the subjects had previous experience with the grab start, so they had to be

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[1]Barry J. Roffer and Richard C. Nielson, "The Grab Start is Faster," Swimming World, 8 (January, 1972), 101.

[2]Eric S. Hanauer, "Grab Start Faster Than the Conventional Start," Swimming World, 13 (April, 1972), 9.

Table 1

A Comparison of the Grab Start and the Conventional Start of One Swimmer Using Photographic Equipment

	Grab	Conventional
Time to initial movement	12/64 sec.	14/64 sec.
Toes leave block	50/64 sec.	One sec.
Hands hit water	One 2/64 sec.	One 17/64 sec.
Feet in water	One 11/64 sec.	One 28/64 sec.
Hand at edge of frame (18' 9")	One 39/64 sec.	One 54/64 sec.
Time in Air: Toes leave to hand touch	16/64 sec.	17/64 sec.
Distance in air	12 ft. 3 in.	12 ft. 11-1/2 in.
Velocity	49 1/6 ft/sec.	49-1/2 ft/sec.

Source: Eric S. Hanauer, "Grab Start Faster Than the Conventional Start," Swimming World, 13 (April, 1972), 9.

trained in this start just prior to the experiment. The swimmers held a glide position for 25 feet after entering the water. Of the six participants, four recorded faster average times using the grab start. For all subjects timed, the means were reported to be 2.991 seconds for the grab start and 3.058 seconds for the conventional start,[1] a difference of over .06 seconds. Michaels did not test the data for statistical significance.

Van Slooten compared the grab start and the conventional start in terms of acceleration, velocity, displacement, and theoretical path of the center of gravity of the body, using a 16 millimeter camera and the Dekan Timer. When he recorded the horizontal acceleration of the center of gravity of the body at take-off, entry, and at 15 feet, the conventional start had the greater time for the entire 15 feet.[2] He concluded the following:

1. The take off from the starting block was faster with the grab start.
2. The grab start placed the swimmer in the water faster.
3. The conventional start put the swimmer farther out into the water.

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[1]Richard A. Michaels, "A Time Distance Comparison of the Conventional and the Grab Start," Swimming Technique, 10 (April, 1973), 6.

[2]P. H. Van Slooten, "An Analysis of Two Forward Swim Starts Using Cinematography," Swimming Technique, 10 (October, 1973), 87.

4. The grab start was faster to 15 feet (1.7 seconds compared to 1.81 seconds).[1]

Van Slooten's study raised the question: At what point does the greater acceleration of the conventional start outweigh the increased take-off speed of the grab start?

In his summary of a comparison of the grab start and the arms-back, Lenon stated there was not a significant difference between the two starts.[2] His test data, however, show eight of the ten were faster with the grab start. The ten swimmers averaged .85 seconds faster to ten yards using the grab start.

Beritzhoff conducted a study in 1973, which compared, through cinematographic techniques, the relative effectiveness of the conventional start and the grab start for breast stroke swimmers. He concluded the grab start was faster to 15.9 feet by .11 seconds, and was significant at the .01 level.

Friedrichsen stated the grab start was used by all eight of the finalists in the 1972 Olympic Trials.[3]

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[1]Van Slooten, p. 88.

[2]Jerry D. Lenon, "A Comparison of Two Types of Racing Starts Used in Competitive Swimming" (unpublished Master's thesis, East Tennessee State University, 1973), p. 24.

[3]Fred W. Friedrichsen, "A Start That Will Grab You," Scholastic Coach, 42 (February, 1973), 42-107.

Gambril credited the grab start for Randy Grimmes' winning the National College Division 100 meter freestyle time in the National Amateur Athletic Union Championships.[1]

Beritzhoff did a study at Chico State in 1974 in which extracts from film were statistically analyzed to determine any significant differences between the two starts. Individual means for each subject on the two starts were compared by tests to determine the best start for each individual. Wilcoxon matched pairs signed ranks tests were applied to determine if one start proves better for a significant number of individuals. A critical ratio test determined if significant differences in performance existed when all trials were combined.

Results of those tests indicated significantly faster times for the grab start for 5 of 6 subjects tested at 15.9 ft. and 4 of 6 faster at 37.5 ft. Results of the Wilcoxon matched pairs signed ranks test indicated a significant number of subjects were faster with the grab start. Results of the critical ratio tests showed the grab start produced significant faster times for combined trials to all distances under investigation.[2]

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[1]Donald L. Gambril, Swimming (Pacific Palisades: Goodyear Publishing Company, 1969), p. 56.

[2]Stephen T. Beritzhoff, "The Relative Effectiveness of Two Breaststroke Starting Techniques Among Selected Swimmers" (unpublished Master's thesis, California State University, Chico, 1974).

It is noted at this point that all grab start studies located by this author describe the grab start with the arm swing down and forward and not the "butterfly" method.

Chapter 3

PROCEDURES

GENERAL DESIGN

The subjects were selected competitive swimmers from high schools in the Des Moines, Iowa, metropolitan area. The six females and seven males were proficient swimmers with five to seven years of competitive swimming experience and had been trained and coached in practice by high school and Amateur Athletic Union coaches in the conventional start and the grab start (Method I). Each subject was checked by the researcher on his/her ability to perform the starts, as prescribed, before each test session. The subjects were coached by the researcher until their starts were proficient and correct. Each subject then did a group of six of one of the starts, being both timed and photographed. The high and the low time from each set was discarded in an effort to keep unusually high or low times from influencing the outcome of the research. A two minute rest period was allowed to guarantee that fatigue was not a factor. Each of the swimmers was tested in the same manner of start at each of three sessions over a period of two weeks.

The swimmers were started by a signal from a registered swimming official using the official National Collegiate Athletic Association commands. Care was taken

to discount any false starts that might occur. The signal activated a timing device which timed the swimmer for fifteen feet from the starting block. A camera photographed his/her start and entry into the water.

From the data collected, an analysis of variance technique was used to compare the means of the starting times designed to answer the question regarding time lapse for the first fifteen feet of the start. The same technique was used with the data collected from the photographs to establish how the starts compared in distance from the starting block and in time taken for the feet to leave the block.

POPULATION AND SAMPLE

The population of this study included all of the racing starts done by the selected competitive swimmers. The starts included the three specified starts mentioned in the definition of terms of this study.

The sampling of this study consists of six starts under each of the three conditions by each of the thirteen selected swimmers.

DATA AND INSTRUMENTATION

Each of the six starts done under each of the three conditions by each of the thirteen subjects (234 trials in all) was recorded in the following way:

1. The Dekan Automatic Performance Analyzer (APA) measured to the nearest one/one-hundredth of a second the time period from the starting signal to the disconnect when the waistband of the subject reached the distance of fifteen feet from the starting block. This time was recorded in a log book.
2. The Kodak Super Eight movie camera photographed each of the starts. The number of frames, at 64 frames a second, was counted from starting signal to the time the subjects feet left the block.
3. The number of frames from start until the swimmer's hands entered the water was counted and recorded in the book.
4. The distance from starting block to point of entry was determined by the photographs and also recorded in the book. One Keifer nonturbulent racing lane marker was placed on each side of the lane the subject used. Each buoy in the lane marker was approximately twelve inches in length. These two lane markers provided a reference point to determine the approximate distance the subject traveled through the air before entering the water.
5. The number of frames from the start until the swimmer reached the fifteen foot mark (determined by a signal light) was recorded and was used as a check

on the timing device.

ANALYSIS DESCRIPTION

The first three steps allowed the researcher to ascertain how each individual subject responded to each of the three starts. The final three steps answered the questions asked in the proposal by presenting a total picture of all the subjects for comparison in each of the three starts.

1. t-tests to compare the means of the number of frames for each of the three types of starts for each of the subjects was used to determine if the individual subject left the block fastest with (a) the conventional start, (b) the grab start, or (c) the "butterfly" start.
2. t-tests to compare the means of the distances traveled for each of the three types of starts for each of the subjects was used to determine if the individual subject traveled through the air farthest with start (a) or start (b) or start (c).
3. t-tests to compare the means of the times to a distance of fifteen feet of each of the three types of starts for each of the subjects was used to determine if the individual subject was fastest with (a), (b) or (c).
4. An analysis of variance of the means of the number

of frames recorded (to show the time lapse before the feet leave the block) for each of the four starts for each of the thirteen subjects was used to determine if swimmers left the block fastest with (a) the conventional start, (b) the grab start, or (c) the butterfly start.

5. The same method was used on distance recorded to determine if the swimmers traveled through the air farthest with (a), (b) or (c).
6. The same method was used on times recorded to see if swimmers covered the first fifteen feet fastest with (a), (b) or (c).

Chapter 4

PRESENTATION OF DATA

FEET LEAVING THE BLOCK (FILM)

Table 2 is the analysis of variance of the means of the photographic frames from the starting signal to the time the swimmers' feet leave the starting block. The analysis was done by utilizing all the results of all the subjects. This table indicates there was a significant difference in the times between the three starts.

Table 2

Analysis of Variance for Number of Frames From Starting Signal to Feet Leaving Blocks with Three Starting Techniques

Sources	df	ss	ms	F
Between Groups	2	108.09	54.05	14.43*
Within Groups (error)	36	134.86	3.75	
Total	38	242.95		

*$p < .001$

Table 3 is the comparison of the number of frames from the time of the starting signal to the time the feet leave the block for the conventional start and for the grab start I. The data indicate the conventional start slower

for all thirteen subjects. A significant difference existed in nine of the thirteen cases.

Table 3

t-Tests for Number of Frames from Starting Signal to Feet Leaving Blocks--Conventional Start vs. Grab Start I--By Subject

	Conventional Start		Grab Start I			
Subject	M	SD	M	SD	t	s
A	16.50	1.00	11.75	.96	6.86	**
B	17.00	3.37	12.75	.50	2.50	*
C	17.75	1.71	17.25	.50	.56	ns
D	17.50	2.12	12.67	1.16	3.43	*
E	20.00	1.41	11.75	.96	9.66	**
F	17.00	.82	14.00	.82	5.20	**
G	15.75	2.36	14.25	1.26	1.12	ns
H	13.00	.82	12.00	.82	1.73	ns
I	18.67	.56	15.00	1.16	4.97	**
J	15.75	2.50	15.00	.82	.50	ns
K	17.00	.82	12.25	1.71	5.02	**
L	16.75	.50	13.00	1.41	5.22	**
M	19.75	.50	17.00	.00	7.33	**

*$p < .05$
**$p < .01$

The comparison of the number of frames from the starting signal to the swimmer's feet leaving the block for

the conventional start and for the grab start II is in Table 4. The grab start II was faster in all but two cases and significant for eight of the thirteen subjects.

Table 4

t-Tests for Number of Frames From Starting Signal to Feet Leaving Blocks--Conventional Start vs. Grab Start II--By Subject

	Conventional Start		Grab Start II			
Subject	M	SD	M	SD	t	s
A	16.50	1.00	11.75	1.26	5.91	**
B	17.00	3.37	13.00	.82	2.31	ns
C	17.75	1.71	16.00	.00	2.05	ns
D	17.50	2.12	11.75	.50	5.80	**
E	20.00	1.41	12.00	1.41	8.00	**
F	17.00	.82	14.00	1.00	4.39	**
G	15.75	2.36	13.67	.58	1.46	ns
H	13.00	.82	14.00	1.00	4.39	**
I	18.67	.58	12.50	1.73	5.81	**
J	15.75	2.50	16.67	2.08	-.51	ns
K	17.00	.82	15.25	.50	3.66	*
L	16.75	.50	12.75	.96	7.41	**
M	19.75	.50	13.25	1.50	8.22	**

*$p < .05$
**$p < .01$

In Table 5, the comparison of the number of frames from the starting signal until the feet leave the starting

block for the grab start I and for the grab start II is presented. The tests indicated no significant difference in time by frames for these two starts in this part of the study. The subjects were almost evenly divided in favoring one start over the other. Specifically, six were faster with the grab start II, five were faster with the grab start I, and two were the same.

Table 5

t-Tests for Number of Frames from Starting Signal to Feet Leaving Blocks--Grab Start I vs. Grab Start II (Butterfly)--By Subject

Subject	Grab Start I		Grab Start II		t	sig. .05
	M	SD	M	SD		
A	11.75	.96	11.75	1.26	0	ns
B	12.75	.50	13.00	.82	-.52	ns
C	17.25	.50	16.00	.00	5.00	**
D	12.67	1.16	11.75	.50	1.45	ns
E	11.75	.96	12.00	1.41	-.29	ns
F	14.00	.82	14.00	1.00	.00	ns
G	14.25	1.26	13.67	.58	.73	ns
H	12.00	.82	12.75	.50	-1.57	ns
I	15.00	1.56	12.50	1.73	2.40	ns
J	15.00	.82	16.67	2.08	-1.49	ns
K	12.25	1.71	15.25	.50	-3.37	*
L	13.00	1.41	12.75	.96	.26	ns
M	17.00	0	13.25	1.50	3.33	*

*p < .05
**p < .01

DISTANCE THE SWIMMER TRAVELS IN AIR (FILM)

Table 6 is the analysis of variance for the distance the swimmer travels in the air from the front of the starting block to the point of hand entry into the water. Utilizing all the results from all the subjects, this part of the test indicates there was not a significant difference between the three starting techniques in the distance traveled through the air by the swimmers.

Table 6

Analysis of Variance for Distance in Air From Starting Block to the Point of Hand Entry into the Water of Three Starting Techniques

Sources	df	ss	ms	F
Between Groups	2	.61	.31	.50(ns)
Within Groups (error)	36	22.16	.62	
Total	38	22.78		

The distance each of the thirteen subjects traveled in the air for the conventional start and for the grab start I is shown in Table 7. In a comparison, eight of the subjects attained greater distance in the air with the conventional start. Two of these were significant distances.

Table 7

t-Tests for Distance in Air From Starting Block to the Point of Hand Entry into the Water--Conventional Start vs. Grab Start I--By Subject

	Conventional Start		Grab Start I			
Subject	M	SD	M	SD	t	s
A	10.13	.48	9.75	.29	1.34	ns
B	9.38	.48	9.25	.29	.45	ns
C	9.13	.25	8.75	.29	1.96	ns
D	9.38	.25	8.75	.35	.58	*
E	10.38	.25	10.25	.50	.45	ns
F	11.13	.63	11.13	.25	0	ns
G	10.00	0	8.63	.48	5.74	**
H	9.25	.29	9.88	.25	-3.27	*
I	9.00	0	8.75	.29	1.46	ns
J	8.50	.71	8.50	.41	0	ns
K	8.88	.63	9.25	.29	-1.08	ns
L	9.38	.25	9.00	0	2.00	ns
M	9.00	0	9.17	.29	-1.20	ns

*p < .05
**p < .01

In Table 8, the comparison of the individual subject's distance in the air from the starting block to the point of hand entry into the water for the conventional start and for the grab start II is given. In contrast to Table 7, these

data indicate four subjects traveled farther in the air with the conventional start when compared to the grab start II.

Table 8

t-Tests for Distance in Air From Starting Block to the Point of Hand Entry into the Water--Conventional Start vs. Grab Start II--By Subject

	Conventional Start		Grab Start II			
Subject	M	SD	M	SD	t	s
A	10.13	.48	9.75	.29	1.34	ns
B	9.38	.48	9.38	.25	0	ns
C	9.13	.25	10.00	.00	-7.00	**
D	9.38	.25	9.88	.25	-2.65	*
E	10.38	.25	10.63	.25	-1.41	ns
F	11.13	.63	11.83	.29	-1.78	ns
G	10.00	.00	8.83	.29	8.37	**
H	9.25	.29	9.75	.29	-2.45	*
I	9.00	.00	8.63	.25	2.54	*
J	8.50	.71	9.00	.00	-1.41	ns
K	8.88	.63	9.13	.25	-.74	ns
L	9.38	.25	9.13	.25	1.41	ns
M	9.00	.00	9.75	.29	-5.20	**

*$p < .05$
**$p < .01$

Comparing in Table 9 the means of each individual subject's distance in the air from the starting block to the

point of hand entry into the water for the grab start I and for grab start II, three subjects attained a greater distance with the grab start I than with the grab start II. Nine subjects achieved greater distance in the air using the grab start II rather than the grab start I; four of these subjects' distances were significant.

Table 9

t-Tests for Distance in Air From Starting Block to the Point of Hand Entry into the Water--Grab Start I vs. Grab Start II--By Subject

	Grab Start I		Grab Start II			
Subject	M	SD	M	SD	t	s
A	9.75	.29	9.75	.29	.00	ns
B	9.25	.29	9.38	.25	-.65	ns
C	8.75	.29	10.00	.00	-8.66	**
D	8.75	.35	9.88	.25	-6.83	**
E	10.25	.50	10.63	.25	-1.34	ns
F	11.13	.25	11.83	.29	-3.48	*
G	8.63	.48	8.83	.29	-.66	ns
H	9.88	.25	9.75	.29	.65	ns
I	8.75	.29	8.63	.25	.65	ns
J	8.50	.41	9.00	.00	-2.45	*
K	9.25	.29	9.13	.25	.65	ns
L	9.00	.00	9.13	.25	-.67	ns
M	9.17	.29	9.75	.29	-2.65	*

*$p < .05$
**$p < .01$

TIME FROM STARTING BLOCK TO A DISTANCE OF FIFTEEN FEET USING DEKAN AUTOMATIC PERFORMANCE ANALYZER

The analysis of variance for the elapsed time from the starting block to a distance of fifteen feet is presented in Table 10. Utilizing the results of all the subjects doing all three starts, the elapsed time for the subject from the starting signal to a distance of fifteen feet was not significant as indicated by this test.

Further study of individual subjects may show some significant differences among the three starts.

Table 10

Analysis of Variance for Time From Starting Signal to a Distance of Fifteen Feet for Three Starting Techniques

Sources	df	ss	ms	F
Between Groups	2	.07	.034	1.18*
Within Groups (error)	36	1.04	.029	
Total	38	1.11	.029	

*probability < .320. Not significant at the .05 level.

Table 11 compares the means of the time elapsed from fifteen feet for each subject using the conventional start and the grab start I.

Four subjects had faster times with the conventional start than with the grab start I, but none of these four were

significant. On the other hand, nine subjects had faster times with the grab start I than with the conventional start; four of these times were significantly faster.

Table 11

t-Test of Time From Starting Signal to a Distance of Fifteen Feet--Conventional Start vs. Grab Start I--By Subject

	Conventional Start		Grab Start I			
Subject	M	SD	M	SD	t	s
A	1.98	.013	1.97	.093	.11	ns
B	2.09	.053	2.03	.042	1.63	ns
C	2.10	.021	2.03	.095	1.54	ns
D	2.11	.049	2.14	.049	-.82	ns
E	2.04	.066	2.01	.065	.60	ns
F	1.96	.098	2.00	.033	-.78	ns
G	2.23	.026	2.16	.031	2.86	*
H	2.16	.087	2.13	.045	.60	ns
I	2.45	.010	2.29	.073	3.66	*
J	2.51	.068	2.51	.069	-.05	ns
K	2.38	.058	2.22	.095	2.64	*
L	2.46	.071	2.16	.073	5.86	**
M	2.27	.066	2.27	.133	-.10	ns

*p < .05
**p < .01

Table 12, the comparison of the time from the starting signal to a distance of fifteen feet by each of the

subjects doing the conventional start and the grab start II, indicates the grab start II (or butterfly start) has the time advantage over the conventional start in all thirteen cases and five of these are significant advantages.

Table 12

t-Test of Time From Starting Signal to a Distance of Fifteen Feet--Conventional Start vs. Grab Start II--By Subject

	Conventional Start		Grab Start II			
Subject	M	SD	M	SD	t	s
A	1.98	.013	1.91	.050	2.62	*
B	2.09	.053	2.05	.067	..88	ns
C	2.10	.021	1.87	.051	8.33	**
D	2.11	.049	2.09	.044	.60	ns
E	2.04	.066	1.96	.024	2.30	ns
F	1.96	.098	1.95	.043	.09	ns
G	2.23	.026	2.20	.029	1.53	ns
H	2.16	.087	2.14	.083	.27	ns
I	2.45	.010	2.21	.045	9.04	**
J	2.51	.068	2.46	.047	1.15	ns
K	2.38	.058	2.32	.044	1.80	ns
L	2.46	.071	2.14	.028	8.30	**
M	2.27	.066	2.15	.064	2.56	*

*$p < .05$
**$p < .01$

The comparison for each of the subjects for the grab start I and for the grab start II in Table 13 gives nine of the subjects faster times with the grab start II than with the grab start I. One of these nine times was significantly faster.

Table 13

t-Test of Time From Starting Signal to a Distance of Fifteen Feet--Grab Start I vs. Grab Start II--By Subject

	Grab Start I		Grab Start II			
Subject	M	SD	M	SD	t	s
A	1.97	.093	1.91	.050	1.18	ns
B	2.03	.042	2.05	.067	-.44	ns
C	2.03	.095	1.87	.051	2.86	*
D	2.14	.049	2.09	.044	1.44	ns
E	2.01	.065	1.96	.024	1.43	ns
F	2.00	.033	1.95	.043	1.67	ns
G	2.16	.031	2.22	.029	-1.52	ns
H	2.13	.045	2.14	.083	-.27	ns
I	2.29	.073	2.21	.045	1.97	ns
J	2.51	.069	2.46	.047	1.20	ns
K	2.22	.095	2.32	.044	-1.86	ns
L	2.16	.073	2.14	.028	.45	ns
M	2.27	.133	2.15	.064	1.69	ns

*$p < .05$

SUMMATION OF DATA

In this study, the grab start I was faster than the conventional start from the starting signal to the time the feet left the starting block for all thirteen subjects. Eight swimmers, using the conventional start had a greater distance from the starting block to point of entry when compared to the grab start I. Of the thirteen subjects, nine reached the distance of fifteen feet from the starting block faster with the grab start I than with the conventional start.

Swimmers using the grab start II were faster off the block from the starting signal than those using the conventional start in twelve of the cases and faster to the distance of fifteen feet from the starting block in all thirteen cases. Four subjects had a greater distance over grab start II with the conventional start.

No significant difference existed between the two styles of grab starts in time from the starting signal to leaving the block. The grab start II did have six more subjects getting greater distance from the starting block and five more reaching the distance of fifteen feet faster.

Additional discussion of the comparisons of the three starts is in Chapter 5.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to compare three competitive swimming front starts at three important points of the start. The three starts are the conventional start, the grab start I, and the grab start II. The three important points of comparison are the time it takes for the feet to leave from the block from the starting signal, the distance the swimmer travels in the air from the starting block, and the time it takes for the swimmer to reach fifteen feet from the starting signal.

A. Table 2 indicates a significant difference does exist between the starts in the mean time it took from the starting signal to the feet leaving the block. The probability of this significance was less than .001.

When examining the starts and the subjects individually (Table 3, 4 and 5), all of the subjects left the starting block faster with the grab start I than with the conventional start. Grab start II had twelve of the thirteen subjects with faster times off the block against the conventional start. The grab start I and the grab start II had no significant difference when compared.

B. The mean of the distance the subjects traveled from the starting block to the point of hand entry into the water did not vary enough from one start to another to be

considered significant.

The subjects traveled through the air farther with the conventional start eight times compared to three times with the grab start I.

Eight of the thirteen subjects traveled farther with the grab start II than with the conventional start.

When comparing the two grab starts, grab start II gave nine of the thirteen subjects a greater distance than grab start I.

C. The analysis of variance between the starts for the mean time it took from starting signal until the subjects reached fifteen feet was not significant.

Nine times the subjects using the grab start I were faster to fifteen feet than with the conventional start. Four of these nine times were significantly faster.

The grab start II was faster for all thirteen of the subjects when compared to the conventional start. Five of those times were statistically significant.

No significant differences existed among the subjects when comparing the grab start I with the grab start II even though grab start II was faster for nine of the thirteen subjects.

The measured factor for swimmers and coaches that stands out as most important is the time from the starting signal to the distance of fifteen feet. Concerning this factor, the grab start II proved to be the fastest for 69

percent of the subjects. The grab start I was the fastest for 31 percent of the subjects.

RECOMMENDATIONS

For further study, the distance of fifteen feet from the starting block should be increased to at least twenty feet to neutralize the advantage gained from the starting acceleration.

The angle of entry of all three starts should also be examined to discover if one has an advantage in time, speed, and/or distance over the other.

BIBLIOGRAPHY

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A. BOOKS

Armbruster, David A., Robert Allen, and Bruce Harlan. Swimming and Diving. 6th ed. St. Louis: C. V. Mosby and Co., 1968.

Burn, J. W. Scientific Principles of Coaching. Englewood Cliffs, N.J.: Prentice-Hall Inc., 1955.

Counsilman, James. The Science of Swimming. Englewood Cliffs, N.J.: Prentice-Hall Inc., 1968.

Gambril, Donald L. Swimming. Pacific Palisades, Calif.: Goodyear Publishing Co., 1969.

National Collegiate Athletic Association Swimming and Diving Rule Book, 1975-76.

Sheehan, Thomas J. An Introduction to the Evaluation of Measurement Data in Physical Education. Reading, Massachusetts: Addison-Wesley Publishing Co., 1971.

Torney, John A. Swimming. New York: McGraw-Hill Book Co., Inc., 1950.

B. PERIODICALS

Friedrichson, Fred. "A Start that Will Grab You," Scholastic Coach, 42 (February, 1973), 42-107.

Hanauer, Eric S. "The Grab Start," Swimming World, 13 (June, 1967), 42.

_____. "Grab Start Faster Than Conventional Start," Swimming World, 13 (April, 1972), 9-10.

Maglischo, Ernest. "Comparison of Three Racing Starts Used in Competitive Swimming," Swimming Technique, October, 1969, pp. 19-21.

Michaels, Richard A. "A Time Distance Comparison of the Conventional and the Grab Start," Swimming Technique, 6 (April, 1973), 16-18.

Roffer, Barry J., and Richard C. Nielson. "The Grab Start is Faster," Swimming World, 8 (January, 1972), 101-102.

Van Slooten, P. H. "An Analysis of Two Forward Swim Starts Using Cinematography," Swimming Technique, 10 (October, 1973), 85-88.

C. UNPUBLISHED

Beritzhoff, Stephen T. "The Relative Effectiveness of Two Breaststroke Starting Techniques Among Selected Swimmers." Unpublished Master's Thesis, California State University, Chico, 1974.

Jorgensen, Layne W. "A Cinematographic and Descriptive Comparison of Three Selected Freestyle Racing Starts in Competitive Swimming." Unpublished Doctoral dissertation, Louisiana State University, 1971.

Lenon, Jerry D. "A Comparison of Two Types of Racing Starts Used in Competitive Swimming." Unpublished Master's Thesis, East Tennessee State University, 1973.

Pelchat, Christian. "A Biomechanical Analysis of Selected Racing Starts in Swimming." Unpublished Master's Thesis, Pennsylvania State University, 1971.

Scheucheuzuber, H. Joseph. "A Biomechanical Analysis of Four Backstroke Starts." Unpublished Master's Thesis, Pennsylvania State University, 1970.

Winters, Clifford N. "A Comparison of the Grip Start and the Conventional Start in Competitive Swimming." Unpublished Master's Thesis, Southeast Missouri State College, 1968.